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The Impact of HIV on Children's Welfare

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Abstract

Children living in HIV/AIDS affected households bear the heaviest burden of the epidemic. Besides direct vertical transmission, HIV/AIDS potentially worsens the children's welfare indirectly through its socio-economic impact. This paper uses household survey data including information about individual HIV infection status to analyze the direct and indirect effects of HIV-infected household members on child mortality, undernutrition and educational attainment for Burkina Faso, Cameroon, Ghana and Kenya. The results indicate that the main channel through which HIV effects the child mortality risk is mother to child transmission. Whereas no effect of HIV is found on child mortality and undernutrition, a negative effect for school enrollment is found for Burkina Faso and Cameroon.

***JEL* Classification:** I12, I30, I31, J13, R20.

Key words: Child Mortality, HIV/AIDS, Undernutrition, Education, Sub-Saharan Africa.

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1 Introduction

As is well known, the HIV/AIDS epidemic dramatically increases mortality rates among young adults in many African countries, which may have also severe negative consequences for the surviving household members. The region that is most strongly affected by the epidemic is Sub-Saharan Africa, showing also relatively poor socio-economic indicators. Here, the demographic impact of HIV/AIDS is devastating. On average, life expectancy at birth has decreased from 50 years in 1990 to 46 years in 2004 (World Bank, 2005). In 2002, about 22 million persons died from AIDS and more than 40 million were living with HIV/AIDS, which accounts worldwide for 70 percent of all infected persons. And about 100 million additional deaths are expected until 2025, as a result of the epidemic (United Nations 2004).

The welfare impacts of HIV/AIDS are similarly devastating, from the national to the individual level. At the national level, the decline of human capital hampers economic development. At the household and individual level, the impact of the epidemic is not only due to killing people but also imposes a heavy burden on surviving family members, especially for children. Children's welfare worsens via two channels. First, directly through mother to child transmission of the epidemic and second, indirectly via the socio-economic impact of the epidemic. This means that HIV/AIDS potentially worsens the children's health, nutritional status and educational attainment beyond the effects of direct vertical transmission. Children living in a household in which the mother or another household member is HIV-positive may have higher morbidity and lower nutritional status and educational attainment than children in unaffected households, even if they are not directly infected. In particular, children suffer from the diminishing capacities of their main caregivers in the household to purchase certain key inputs for the children, as a result of a loss of household income due to HIV/AIDS.

During the last 15 years, many researchers have addressed the demographic, social and socio-economic impacts of HIV/AIDS. Unfortunately, reliable data about HIV/AIDS at the individual level is still very limited, especially in Sub-Saharan African countries, which hampers the micro-analysis of the determinants and impacts of the epidemic. Therefore, only very limited empirical evidence exists about the impact of HIV on children's welfare through channels that go beyond the mother to child transmission. Taha et al (1995) find a considerable higher child mortality risk of HIV-infected mothers, whereas Ryder et al (1994) find only very little differences in social indicators among orphans whose mother was HIV-positive, compared to orphans whose mother was non infected. However, these studies suffer from the lack of data on HIV/AIDS at the individual level and are based on small-scale surveys.

This paper contributes to the literature by analyzing the effects of HIV on different outcomes of children's welfare at the micro-level using large scale household survey data. In particular, the paper analysis the impacts of HIV-infected household members on child mortality, undernutrition and educational attainment. So far, no analysis exists that uses household survey data including information about individual HIV infection status of currently living individuals that is representative at the national level to investigate the impact of HIV on children's welfare. The aim of the paper is to shed more light on the effects of the HIV/AIDS epidemic on the welfare of children that are caused both by direct vertical transmission and by worsening socio-economic conditions.

For the econometric modelling, first a survival model framework is used to estimate the impact of the HIV status of household members on child mortality, which allows for accounting for unobserved heterogeneity. Second, an OLS regression model is used to estimate the impact on child undernutrition and education. The model is estimated for four African countries: Burkina Faso, Cameroon, Ghana and Kenya using national representative

Demographic and Health Survey (DHS) data.

The rest of the paper is organized as follows. Section 2 describes the channels through which HIV/AIDS effects economic development and children's welfare and provides a review of the empirical literature on the impact of HIV/AIDS. Section 3 describes the methodology of the empirical approach to estimate the determinants of HIV infection risk and the impacts of HIV/AIDS on children's welfare. Section 4 describes the history of HIV/AIDS in the four countries and presents the data sources. In Section 5 descriptive statistics and the estimation results of the analysis are presented. Section 6 concludes.

2 Literature review on the impact of HIV/AIDS

The main transmission channel of HIV/AIDS is sexual intercourse, which accounts for around 80 percent of all HIV transmissions.[1] The second important transmission channel is mother to child transmission, which accounts for around 5 percent of all transmissions.[2]

The national history of HIV/AIDS is assumed to follow in most developing countries a similar pattern. In the early stages of the epidemic, often the wealthier and better educated population in urban regions is affected. Several studies using data for African countries from the beginning of the 1990s show a higher infection risk among the better educated population group (see, e.g. Grosskurth et al, 1995; Hargreaves et al, 2001; Smith et al, 1999; Cogneau and Grimm, 2006). Then, once the epidemic reaches also the poor population, i.e. those with very limited knowledge about HIV transmission

[1]Due to biological, socio-economic and socio-cultural reasons, women have a considerably higher infection risk than men (World Bank, 1997).

[2]Morgan et al (2002) estimated based on longitudinal data from rural Uganda that the median time from seroconversion to AIDS is about nine years and from AIDS to death about nine month. In addition, they found no differences between developing and developed countries. However, Piwoz and Preble (2002) show that the time period between HIV infection and AIDS-related death is considerably shorter in developing countries than in industrialized countries because of the higher exposure to other diseases, poor health care and sanitation and malnutrition.

and prevention, the epidemic begins to spread over the society as a whole, which is reflected in increasing prevalence of the epidemic. In the next stage, the literature shows that the better educated, i.e. those who are more able to acquire knowledge about HIV/AIDS and its infection risk, change their sexual behavior (see, e.g. Kremer, 1996; Glynn et al, 2004). This, accompanied by policy instruments to promote knowledge about the epidemic and the use of condoms, leads then to a slow down in the spread of the epidemic and countries experience a decline of HIV/AIDS cases. However, the poor are often bypassed by this decline, because they still have limited knowledge about HIV/AIDS. Furthermore, especially if they are very poor and if they have to fight to satisfy their basic needs in the short term (United Nations, 2005a; Haddad and Gillespie, 2001), the poor population does not change their sexual behaviors because they can not effort to deal with this long term risk.[3]

HIV/AIDS has various impacts on welfare, from the national to the individual level. At the macro-level, basically, economic researchers indicate two main channels through which the HIV/AIDS epidemic has negative macroeconomic impacts. First, it kills people. The cost of HIV/AIDS are mainly through its impact on human capital. HIV/AIDS directly decreases human capital because primarily the working age population is affected and higher mortality rates shrinks the labor supply. Indirectly, and especially in the long run, HIV/AIDS hampers the accumulation of future human capital through higher child mortality. Second, the epidemic makes people ill. Longer and more frequent times absent from work as a result of the epidemic may lower

[3] This has important policy implications. The usual argument of political instruments to reduce HIV/AIDS is to improve the knowledge about the epidemic and its transmission channels and to spread the use of condoms. While this is a very important instrument, it might not be enough, especially when the very poor population is the target group of such initiatives and if they are not willing to change their behavior. Recent data show that the very poor are relatively less likely to use condoms (United Nations, 2005a). Therefore, instruments to reduce HIV/AIDS through, for example, the use of condoms have to be accompanied by measures to reduce poverty and inequality.

labor productivity of infected workers. In addition, the epidemic leads to increased public health care expenditures both through the increase on people needing medical services and higher costs of the antiretroviral (ARV) treatment of AIDS compared to other diseases.[4] Both impacts have negative effects on savings and investments leading to an overall growth decline.

During the last two decades, a growing literature on the macro-economic impact of HIV/AIDS arose. For example, Over (1992) estimates a decline of one third percentage point due to its effect on savings and on skilled labor supply. Cuddington (1993) developed a Solow-type growth model and estimates a decline in GDP in 2010 by 15 to 20 percent for Tanzania. Arndt and Lewis (2000) find substantial divergencies in growth of GDP between two scenarios of AIDS and no-AIDS. They estimate for South Africa that the level of GDP is about 17 percent lower by the year 2010, mainly as a result of higher public expenditures for health services and lower productivity, which results in lower growth of investments. Bonnel (2000) estimates an annual decline GDP growth of 0.7 percentage points using cross-country regression for Africa between 1990 and 1997.[5] More recently, Bell et al (2003) emphasize the importance of human capital and transmission mechanism across generation and argue that the long run impact of HIV /AIDS on GDP growth is even stronger and may even leads to a collapse of the economy.

However, researchers indicate also some channels through which the AIDS epidemic has a compensating or even positive effect on economic growth and that the effect of HIV/AIDS on GDP per capita is generally overstated for several reasons (see, e.g. Bloom and Mahal (1997). First, the often existing labor surplus could lower the effect of lower labor productivity due to rising mortality and morbidity among the working age population as a re-

[4]See, for example, Hellinger (1993).

[5]Similar negative effects on GDP growth due to the epidemic are found, for instance, by Jamison, Sachs and Wang (2001), MacFarlan and Sgherri (2001).

sult of AIDS. Second, social and economic adjustments could mitigate the rising public expenditures for health care services due to HIV/AIDS. Third, changes in behaviors over time are usually not considered when forecasting the number of infected person. Finally, higher infection rates among the poor with generally low incomes would diminish the impact on average per capita terms of well-being. If the decline in GDP is absorbed by higher infection rates and resulting higher number of deaths among the poor, i.e. when the dominator of GDP per capita shrinks more than the nominator, this might lead to misleading welfare implications of only small shrinking or even rising GPD per capita.[6] Bloom and Mahal (1997) found only an insignificant impact of HIV/AIDS, based on a cross-country analysis for 51 developing and developed countries. Young (2005) identifies decreasing fertility rates and, therefore, higher per capita investments in human capital as another channel through which AIDS may affect the economy in a positive manner and which stands against the negative long term growth effect of a loss in human capital due to higher mortality rates.[7] There exist also other studies that find only a small or insignificant effect of the epidemic on the macro-economic performance of African countries. In Botswana, where almost every third is HIV positive, experiences a strong growth of GDP per capita (World Bank, 2005).

At the micro-level, the empirical evidence shows also severe negative

[6] This problem of not taking into account premature mortality into analysis of per capita well-being is not only of particularly relevance in the case of the HIV/AIDS epidemic. In the context of the worldwide demographic change, the incorporation of variations in life expectancies, changes in population size and mortality when performing aggregate welfare comparison over time and space is recently discussed in a growing literature. For theoretical implications see, for example, Kanbur and Mukherjee (2003), Becker, Philipson and Soares (2005), Blackorby, Bossert and Donaldson (2005) and for empirical illustrations Ravallion (2005) and Grimm and Harttgen (2006).

[7] In particular, he states that when countries are affected by high infections rates the fertility rates decrease, directly to less unprotected sexual activities because of higher risks and indirectly to an increasing value of the time of women because of the shrinking labor supply, which enhances future per capita income. Using a Beckerian household model he finds that the fertility effects dominated the effect of a shrinking human capital accumulation of orphaned children in South Africa.

economic and social impacts of HIV/AIDS on household and individuals. Limited labor productivity of sick household members has income and substitution effects. HIV/AIDS affected households experiences a temporary loss of income if an income earner is not able to work and, finally, the death of an income earner leads to a permanent loss of income. Often, affected households have to sell assets to compensate the loss an income (Mutangadura, 2000 and Béchu, 1998). Particularly, poor households, which are more vulnerable to shocks are most strongly affected. Poor households can, if at all, only very limited cope with losses in income, because they own no assets to sell or can not effort medical care for affected household members. In general, poverty increases both the risk and the impact of HIV/AIDS. For example, Booysen (2003) shows that in South Africa poor households that experienced an AIDS-related death have a more than twice as high probability to fall into long term poverty than non affected households. In addition, high expenditure for medical care and the loss of income of sick or dead income earner lead to a reallocation of recourses within HIV/AIDS affected households. For example, affected households often experience a decline in consumption including a reduction in food consumption resulting in higher rates of undernutrition (Topouzis, 1994).[8]

Children living in HIV/AIDS affected households face the heaviest burden as the result of the direct loss in income and of the resource allocations. In this paper, the focus is on three socio-economic impacts: the impact on child mortality, on undernutrition and on education. HIV/AIDS is one of the leading causes of child mortality in Africa (see, e.g. Hill et al, 2001). Under five mortality risk is estimated to be two to five times higher for children whose mother is HIV-infected than for those whose mother is HIV-negative (Adetunji, 2000 and Taha et al, 1995). The epidemic affects the mortality risk of children directly and indirectly. The direct impact is through

[8]In many countries a death of the income earner leads in addition to high expenditure through high funeral costs (Menon et al, 1998).

mother to child transmission during pregnancy, delivery and breastfeeding.[9] Without any interventions, about 20 to 40 percent of HIV-infected mothers transmit the infection to their children (De Lock et al, 2000; World Bank, 1997) and the median age of death of an HIV-infected child in Africa is about two years (see, e.g. Spira et al, 1999). The indirect effects are through the socio-economic consequences of HIV/AIDS affected households resulting in less care capacities of the parents for their children and higher risk of illness.

The empirical literature shows also negative impacts of HIV/AIDS on the nutritional status of children. Similarly to child mortality, also here direct and indirect effects can be observed. Directly, infants of HIV-infected mothers often have a low birth weight, which leads to an increased risk of morbidity and mortality and chronic undernutrition. In addition, undernutrition directly accelerates the progression of the disease towards AIDS-related death through effects on the immune system and its impact on nutrients intake, absorption and utilization (Piwoz and Preble, 2000).[10] Indirectly, HIV/AIDS effects the precondition of a sure nutritional status of a child, because the quantity and quality of food decreases as a result of less care capacities, worsening the nutritional status of the children.

Empirical evidence exists also on severe negative impacts of the HIV/AIDS epidemic on the educational attainment of children living in affected househlds. Because of resource allocations within households as the result of sick or died income earners, children often have to be withdrawn from school to reduce costs resulting in lower potential for future earnings. For instance, Mutangadura (2002) finds that in Zimbabwe the share of children who go to school after an AIDS-related death decreases by 20 percent because of the lack of

[9]Similarly, breastfeeding of HIV-infected mothers bears also considerable risk for the mother. The high energy demand of breastfeeding weakens the mother, which leads also to an acceleration of the progress of the disease. Mortality rates among HIV-infected mothers who gave breast milk is three times higher than for infected mothers who did not (Nduati et al, 2001).

[10]In contrast, a good nutritional status, particular vitamin A reduces the infection risk (Haddad and Gillespie, 2001).

money or because the children have to go to work to compensate the loss in household income. Topouzis (1994) finds that only every fifth child remains in school after the death of a household member. Graff Zivin et al (2006) estimate the impact of antiretroviral treatment on children's schooling and nutritional status in Kenya and found that the treatment of adult household member rise weekly schooling hours by 20 percent and improves the nutritional outcome of children. The impact of HIV/AIDS on education is even worse for children who become orphans, because it decreases strongly their future welfare perspective (see, e.g. Bicego et al, 2003; Case et al, 2004). Especially, if orphans live with other adults, these adults might not invest in the children because they are not expected to care for them in retirement age (Ainsworth and Semali, 2000).

3 Methodology

To analyze the impact of HIV on child mortality, this paper applies a survival model framework. The idea of survival or hazard models is to analyze the time to the occurrence of an event, which is in this case the death of the child.[11] In particular, this paper employs a semi-parametric Cox proportional hazard continues time model (Cox, 1972), which is the most popular form of survival models when analyzing patterns of child mortality. An advantage of hazard rate models for the analysis of survival data, compared to standard cross-section regression models, is the capacity to deal with several kinds of censored observations. The most typical form of censoring when analyzing child mortality rates is right censoring, which means that the subject has not had the event (death) when the observation time ends, e.g. the child is three years old when the observation time ends and one does not

[11]In general, survival analysis can be defined as the analysis of rates of the occurrence of the failure during a specific risk period (Yamaguchi, 1991). Survival analysis has become a common econometric instrument to analyze the determinants of child mortality (see, e.g. Ridder and Tunali, 1999; Van der Klaauw and Wang, 2004).

have information whether the child is going to die before he or she reaches the age of five or not. Omitting the right-censored cases simply from the sample can generate serious biases in the parameter estimation. In survival analysis, one can include the information about the right-censored subjects up to the time of censoring without making any assumption about the date the event occurs in the future.[12]

Based on Cox (1972), to illustrate the model, let T be the nonnegative survival time, which is the time period between nonoccurrence and occurrence of failure, i.e. the age between zero and five years. The immediate risk of failure of an individual i, which is alive at time t, is defined as the hazard rate or the or age-specific failure rate and expressed through the hazard function.[13] Let $h(t)$ denote the hazard function of survival time T and $x_i = (x_{1i}, x_{2i}, ..., x_{pi})$ be a vector of p independent observed covariates for individual i. The hazard function for individual i given the vector x can then be written as

$$h_i(t|x) = h_0(t)g(x_i), \tag{1}$$

where $g(x_i)$ is a function of the covariates and the term $h_0(t)$ is defined as the baseline hazard function, which is the hazard for the respective individual, when all independent covariates are equal to zero. Assuming continuously distributed survival times and no ties, the hazard function can be written as

$$\begin{aligned} h_i(t|x) &= h_0(t)exp\left(\beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_p x_{pi}\right) \\ &= h_0(t)exp\left(\sum_{j=0}^{p} \beta_j x_{ji}\right). \end{aligned} \tag{2}$$

Equation (2) shows that the underlying hazard rate is a function of a set

[12]For a detailed description of survival models, see, e.g. Lee (1992).

[13]In the context of child mortality, the hazard rate can also be termed as the age-specific mortality rate (Ridder and Tunali, 1999). The mortality rate at time (age) t refers to as the magnitude of the child mortality at this age, given that the child has survived to age t.

of independent covariates.[14] To simplify the model, equation (2) can be linearized by dividing both sides by $h_0(t)$ and then taking the logarithm of both sides:

$$log_e \frac{h_i(t)}{h_0(t)} = \beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_p x_{pi}$$
$$= \left(\sum_{j=0}^{p} \beta_j x_{ji} \right). \quad (3)$$

The left-hand side of equation (3) shows the hazard, i.e. the relative risk of individual i and the right-hand side is a linear function of the covariates x_{ji} with their respective coefficients β_j.[15] To estimate equation (3), a maximum likelihood approach is used. In contrast to parametric models, the semi-parametric Cox proportional hazard model does not require the specification of a parametric form of the hazard function $h_0(t)$.[16]

One of the problems that arise is the possible existence of unobserved heterogeneity. The child mortality risk may also depend on unobserved individual and household characteristics and on unobserved biological frailties. It is important to account for this unobserved heterogeneity to avoid inefficient and inconsistent parameter estimation (Van der Klaauw and Wang, 2004).[17] Therefore, the model is extended to incorporate also unobserved

[14] Given, that there exist no left-censored observation, the likelihood function to estimate the hazard rate for a set of independent observations of duration $i = 1, ..., I$ can be expressed as $\prod_{i=1}^{I} h_i(t_i)^{\delta_i} S_i(t_i)$, where t_i is the duration of risk for individual i, $S_i(t_i)$ is the survival function, defined as the probability that an individual survives longer than t ($S(t) = P(T > t)$), and δ_i is a dummy whether the event occurred for i at time t_i ($\delta_i = 1$) or the observation was right censored at time t_i ($\delta_i = 0$). Both $h(t)$ and $S(t)$ depend on the values of the covariates of subject i. For a right-censored observation the contribution to the likelihood function remains $S_i(t_i)$, i.e. the probability of not having the event between 0 and t_i. Therefore, also the information of right-censored observation can be included into the model (Yamaguchi, 1991).

[15] The function $exp()$ is simply chosen to avoid that the hazard function ever turn negative. Semi-parametric means that the analysis makes no assumption about the distribution of the hazard function, whereas the effects of covariates are still parameterized to affect the baseline hazard function in a specific way.

[16] Therefore, the semi-parametric Cox proportional hazard model is more robust than parametric models, because it is not vulnerable to miss-specification of the baseline hazard. The disadvantage of this approach, however, is a loss in efficiency. If one would know the true functional form of $h_0(t)$ one would obtain more efficient estimation results of the β_x.

[17] When unobserved heterogeneity exists and if it is not considered in the model, one

heterogeneity. Thus the hazard function (3) becomes to

$$log_e \frac{h_i(t)}{h_0(t)} = \sum_{j=0}^{p} \beta_j x_{ji} + \alpha_i, \qquad (4)$$

where α_i is the group i level frailty.[18]

To analyze the impact of HIV on undernutrition and school enrollment, controlling for individual and household socio-economic and demographic characteristics and environmental factors, a standard ordinary least squares (OLS) model is applied. For each country the following equation is estimated:

$$y_i = \sum_{j=0}^{p} \beta_j x_{ji} + u_i, \qquad (5)$$

where y_i is either the stunting z-score for individual i or the number of enrolled children per household.

4 Data

Fortunately, Demographic and Health Surveys (DHS) conducted in recent years include HIV test results at the individual level for selected Sub-Saharan African countries. These DHS surveys are the first large scale households survey data sets providing HIV testing results.[19] Thus, the data sets provide interesting scope for the analysis of the impact of HIV on the household's welfare and may give new insights into the causes and impacts of the epidemic. Besides the information on HIV testing results, the DHS surveys

either overestimates a negative duration effect or underestimates a positive duration effect (Yamaguchi, 1991).

[18] The group i level frailty α_i is assumed to be gamma distributed.

[19] In particular, the DHS data sets provide a sub-sample including HIV infection testing results for ales and females. As the DHS data sets are representative at the national level, the HIV sub-sample is compared to the full sample concerning the question if also the sub-sample is national representative. Table A1 compares the two data sets by estimating the probability of being in the full sample on a the set of variables that are used in the analysis of this paper. Almost all variables are not significant indicating that the results of the analysis using the HIV sub-sample can be interpreted as representative at the national level. However, the urban dummy is significant in all countries indicating the results are only limited interpretable as national representative.

provide also information on anthropometric outcomes of children, child mortality and socioeconomic individual and household characteristics.

The Sub-Saharan African countries analyzed in this paper are Burkina Faso (2003), Cameroon (2003), Ghana (2003) and Kenya (2003). Concerning human development, Ghana is the only country of the sample that is classified as a 'Medium Human Development' country by the United Nations with a Human Development Index (HDI) rank of 138. The other three countries are classified as 'Low Human Development' countries with HDI ranks of 148 (Cameroon), 154 (Kenya) and 177 (Burkina Faso), which is only higher ranked than Sierra Leone and Niger (United Nations, 2005). In all countries, poverty rates[20] are around 50 percent and GDP per capita is low. In 2003, Cameroon, Kenya and Burkina Faso had a life expectancy between 46 and 48 years, whereas the situation in Ghana was better with a life expectancy of about 60 years (World Bank 2005). In addition, all countries suffer from high incidence of child mortality of more than 100 per 1000 children and of child undernutrition of around 40 percent, compared to African average rates of 17.1 percent for child mortality and 29.4 percent for malnutrition (weight for age) (World Bank, 2005). At present, it is not very likely that the four countries will reach the Millennium Development Goals (MDG) in 2015.[21]

In total, the data sets contain information on 13734 children living in 5629 households.[22] As dependent variables for the analysis of the impact of HIV on child mortality the hazard rate of children under five years of age is used.[23] For the impact on undernutrition the stunting z-score of children under five is used as the dependent variable.[24] A child is considered as

[20] considering the poverty line of below 1 $ ppp per day.

[21] where Ghana has the best chance though.

[22] See next section for descriptive statistics.

[23] This paper does not separate between neonatal deaths, i.e the child dies within the first month of life and post-neonatal death, i.e. the child died between the second month and the first year of life, as for example proposed by Adebayo et al (2004), because this did not change the estimation results.

[24] The DHS surveys provide z-scores for anthropometric outcomes for children under

stunted if the stunting z-score (height for age) is below -2 standard deviation from the median of the reference category (WHO, 2006). For education the percentage of enrolled children aged between five and fifteen per household is used. The impact of HIV is measured both through the HIV status of the mother or whether the male partner is HIV positive.

As independent variables to estimate the effect of HIV on children's welfare a set of household socioeconomic and child characteristics are included into the regression models. In addition, to control for urban areas, the household size[25], the number of children and a dummy whether the household is female headed are included.[26] As the DHS surveys provide no information on income or consumption an asset based approach is applied to obtain information about the material well-being of household (Sahn and Stifel, 2001). For this, an index based on a factor analysis, proposed by Filmer and Pritchett (2001) is derived. As assets to calculate the index dummy variables whether whether in the household exists a radio, TV, refrigerator, bike, motorized transport, low floor material, toilet, drinking water. Of course one could include the assets separately into the regression, but the use of an aggregate index has two main reasons: First, it provides an income proxy of the household which can be used to analyze distributional differences of the impact of HIV or the distribution of HIV itself. Second, as the assets are correlated, their coefficients are likely to provide no significant effects if they are included separately, which would however lead to misleading interpretation of the estimation results.

As child characteristics, the sex of the child is included to control for a

five years of age, particular the z-scores for weight for age, weight for height and height for age.

[25]As the household size is arguable endogenous, i.e. households in which many children die tend to be larger to compensate the loss of the dead children, the variable is not included directly into the regression. Instead in instrument variable approach is applied, where as instrument variable the mean household size per cluster is used.

[26]HIV/AIDS contributes to a rising share of female headed households which potentially worsen the situation of food security for the children.

possible gender bias, which is often found in the empirical literature on child mortality and undernutrition (see, e.g. Marcoux, 2002; Klasen, 1996). Other important determinants of child mortality and undernutrition are if the child is the first born child and if the child was immediately breastfed after birth by the mother.[27] In addition, the regression models captures also the access to health services, by including a dummy whether the child received all possible vaccinations[28], whether the child received vitamin A and whether the mother received prenatal care. Furthermore, the education of the mother is included. Here, the argument is twofold. First, a better educated mother might be more able to process information or to acquire skills to take care of her children (for example in the case of illness) and second, a better educated mother has a higher earning potential. In addition, the nutritional status of the mother is included, which is supposed to have a strong negative impact on the nutritional status of the child.[29]

For the estimation of the impact of HIV on child education, also the described household socioeconomic characteristics enter the regression model. Besides the educational level of the household head, information on the educational status of the mother also controls for possible gender bias in education. Information whether the mother works for cash is also included, because it might have a positive effect on the probability that children are sent to school.[30]

[27]Breastfeeding in the first month of life plays an important role for the development of the child, because the breast milk meets most of the child's nutritional needs and makes the child more resistent against against diseases (see, e.g. Ramalingaswami et al, 1996). However, breastfeeding is also a channel of mother to child transmission, which means that it might have a negative effect when the mother is HIV positive.

[28]To avoid the problem of endogeneity, i.e. that the number of vaccinations is an increasing function of the age of the child, the dummy whether the vaccinations process is completed is defined as follows: the first 2 month after birth are not considered as incomplete if no vaccinations were received, for the age between 3 and 6 months the dummy is one if the child has received at least 3 vaccinations, for the age between 7 and 9 months if the child has received at least 6 vaccinations and between 10 and 12 months if the child has received all 8 vaccinations.

[29]As a measure of the nutritional status of the mother the body mass index (BMI) is used. A mother is considered as malnourished if the BMI is below 18.5.

[30]This arguments holds especially for female ch

5 Results

5.1 Descriptive Statistics

Looking at the HIV/AIDS epidemic, the countries have experienced different histories regarding the development of the epidemic during the last 20 years. In Kenya, the first official AIDS case was reported in 1984, followed by Cameroon in 1985. In Burkina Faso and Ghana the first cases were reported in 1986. Figure 1 shows the number of reported AIDS cases by year and country and describes the history and different stages of the epidemic for the countries over time.[31]

[insert Figure 1 here]

All countries show the initially growing AIDS prevalence as described in section 2. In the first years of the epidemic, Kenya has experienced the highest growth of AIDS cases in the sample. Already at the beginning of the 1990s AIDS cases began to decline rapidly. Compared to Kenya's development, Ghana, Cameroon and Burkina Faso are in an earlier stage of the epidemic but show a similar history of the epidemic. After a continuous rise, in Ghana and Burkina Faso AIDS cases started to decline around the year 2000.

Table 1 shows the HIV infection rates by sub-groups and countries. Cameroon and Kenya are considerably stronger affected by the epidemic than Burkina Faso and Ghana. In Kenya, in about 7 percent and in Cameroon in

countries the gender bias in education of children is found to be lower if the mother works and, therefore, strengthen her bargaining power position in the household (Alderman et al, 1996).

[31]However, one should be careful when comparing the reported AIDS cases across countries. The number of reported AIDS cases is only a very crude indicator of the actual HIV/AIDS prevalence and depends heavily on the reporting systems within countries. For example, if the share of people living in urban areas strongly differs between countries than comparing the numbers of AIDS cases across countries can be misleading because first, prevalence of AIDS is higher in urban areas than in rural areas and, second, reporting institutions are usually located in urban areas resulting in higher reporting in urban than rural areas.

about 6 percent of all households live at least one HIV-infected person, compared to about 2 and 3 percent in Burkina Faso and Ghana, respectively.[32] Whereas in Burkina Faso, Cameroon and Ghana the age group between 25 and 59 years is more affected, the opposite is found for Kenya.[33]

[insert Table 1 here]

The spatial distribution of the epidemic follows the usual pattern. In urban areas, the HIV infection rates are considerably higher than in rural areas. In Burkina Faso, HIV infection rates are more than 3 times higher in urban areas than in rural areas (4.01 compared to 1.22 percent). Only in Kenya the HIV infection rate is slightly higher in rural than in rural areas. Looking at the infection rates of mothers, Table 1 shows a similar picture as for the total household. The highest rates are found in Kenya with 8.88 percent and lowest infection rates are found in Burkina Faso with 1.50 percent.

To get a picture of how the HIV infections are distributed over welfare groups in the countries, Table 2 shows the HIV infection rates for the asset index quintiles. In Burkina Faso, Cameroon and Ghana the poorest quintile has the lowest infection rate, whereas the richest quintile has the highest rate. This indicates that especially the wealthier population group is affected by the epidemic. For example, the ratio of the first to the fifth quintile is 0.10 in Burkina Faso.[34] In contrast, Kenya shows a different picture. Here, Table 2 shows that the poorest quintile has the highest infection rates,

[32]Overall, the HIV prevalence in the DHS data sets is consistent with the prevalence published by UNAIDS (UNAIDS, 2006). In addition, in a recent paper Oster (2006) provides a new methodology to estimate the HIV prevalence based on mortality data on siblings. By providing consistent estimates of HIV prevalence over time and across countries she found that the HIV prevalence of the DHS surveys are not underestimated.

[33]The distribution of HIV over age is also shown in Figure A1.

[34]However, as Cogneau and Grimm (2006) already pointed out for Côte d'Ivoire, high infection rates are also observed for the second quintile, i.e. whom they call "the rich of the poor". Looking, for example, at the second and fourth quintile in Burkina Faso, the poorer quintile has considerably higher infection rates than the richer quintile (1.33 and 2.27 percent).

which is reflected in a ratio of the first to the fifth quintile of 1.16.[35] This indicates again that Kenya has reached a different stage of the epidemic than the other countries. Comparing these findings about the socio-economic distribution of HIV infections with the findings of the empirical literature described in Section 2, only Kenya has reached the stage during the history of the epidemic where infection rates spread away from the wealthier to the poorer population.[36] The other countries show, in spite of decreasing overall infection rates, still higher rates among the richer population group and among the lower middle class.[37]

[insert Table 2 here]

Table 3 presents some descriptives for child mortality, undernutrition and education, for the total data set and by asset index quintiles. The total values for child mortality show considerably high values in all four countries. In contrast to HIV infections Burkina Faso has the highest rates of child mortality with 16.47 percent compared to Ghana with the overall lowest child mortality rate of 10.68 percent.

[insert Table 3 here]

The distribution of child mortality over the asset index shows a clear bias towards the poor. On average, the child mortality rates are about two times higher for the poorest quintile than for the richest quintile. In the case of undernutrition, the situation of inequality is even worse. In Ghana, half of all children in the first quintile are stunted (47 percent) compared to 'only' 15 percent in the fifth quintile. Cameroon, Ghana and Kenya have quite similar total undernutrition rates of about 35 percent. Again, in Burkina

[35]The distribution of HIV over the asset index is also shown in Figure A2, which also indicates the slight overhang of infection rates among the wealthier population groups than the poor.

[36]As also found, for example, by Glynn et al, (2004).

[37]This was also found, for example, by Hargreaves et al (2001) and Cogneau and Grimm (2006).

Faso the situation is worse with a stunting rate of even 44 percent. The situation of school enrollment is also alarming. In Burkina Faso, only 37 percent of children aged between 5 and 15 years go to school, which is 80 percent less than in Cameroon, where 68 percent of the children are enrolled. Concerning the distribution of educational opportunities for different welfare groups, Table 3 shows substantial inequalities between the quintiles in all countries except Kenya.

To provide a more specific insight about the situation in the countries, table 4 provides descriptive statistics on specific household demographic and socio-economic characteristics and on sexual behavior and knowledge about HIV/AIDS. For example, Burkina Faso has the highest rates of malnourished mothers of 17.56 percent. Cameroon, which has the highest school enrollment rates has also the highest rates of primary education of the household head (48.09 percent). Worth noting is also the overall bad situation of access to piped drinking water. In Burkina Faso, only 3.54 percent of household have piped drinking water and also Ghana and Cameroon show rates below 10 percent. Only in Kenya the situation is slightly better where almost 14 percent of households have piped drinking water. Looking at the situation of knowledge about HIV/AIDS, Table A1 shows that in all countries nearly all respondents have heard of AIDS. For example, in Cameroon 46 percent know someone with AIDS and 62 spoke about AIDS with the spouse. However, the knowledge about specific transmission risk factors is still very limited. In Kenya, where 95.25 percent know about mother to child transmission, only 12.47 percent know about other risk factors.[38]

[insert Table 4 here]

[38] Regarding the sexual behavior, for example, Table 4 shows also large differences in the use of condoms. While around one half of the respondents reported sexual intercourse during the last four weeks, in Burkina Faso 53.82 percent reported also that they used no condom, compared to only 0.26 percent in Ghana. Similar rates are observed for HIV-infected respondents. However, as already mentioned, these information are extremely vulnerable to measurement error due to misreporting.

5.2 Estimation results

Table 5 shows the regression results for child mortality. Concerning the socio-economic characteristics of the child and the family, overall, Table 5 shows the usual pattern that, overall, child mortality can only hardly be explained.

[insert Table 5 here]

Regarding the socio-economic characteristics of the child, very similar effects are found across countries. Three main determinants of child mortality could be identified, breastfeeding, prenatal care and a complete vaccination process. As expected, breastfeeding immediately after birth significantly reduces the mortality risk of children, which is in line with the general knowledge about the importance of the colostrum that contains a large number of antibodies and basically works as a first immunization. In addition, also a strong negative effect on child mortality is found if the vaccination process of the child is completed and if the mother has received prenatal care, which reflects the access to the medical care system. Differences between determinants across countries are found, for example, for female headed household. Whereas in Ghana, a female headed household significantly increases the mortality risk, it decreases the risk in Burkina Faso and no significant effect is found for the other two countries. Interesting to note is that no gender bias could be identified in all four countries. In Kenya, an even negative and significant effect on child mortality is found if the sex of child is female.

Quite surprisingly, some characteristics of the mother have a much lower effect on child mortality than expected. For example, the mother's educational level, measured if the mother has primary education, has no significant mortality decreasing impact in all four countries.[39] Even more surprisingly

[39]However, the educational level of the mother influences other determinants of child mortality, which directly effects child mortality like fertility or feeding practices, which are separately considered in the regression model.

is the influence of wealth, measured by the asset index, on the reduction of the child mortality risk. Whereas no significant effect was found for Burkina Faso, Cameroon and Ghana, the asset index has even a positive and significant effect in Kenya.[40] In addition, the percentage of children who recently suffered by fever has only a significant positive effect on mortality in Ghana. And although the percentage of access to piped drinking water show the right sign, it is insignificant in all countries.

Turning to the impact of HIV, Table 5 shows a strong and significant effect for the HIV status of the mother in all four Sub-Saharan African countries. If the mother is HIV positive considerably increases the mortality risk. For example, a simulation if all HIV infected mothers in the sample were HIV negative show that this would reduce the hazard rate in Cameroon and Kenya by about 8 percent and in Ghana and Burkina Faso around 3 percent. The question is now, how this result can be interpreted regarding the question of the channel through which HIV effects the welfare of the children, i.e. if this result shows only the mother to child transmission of the epidemic or if one can also draw any conclusion about the indirect channel of a lower capacity of HIV infected mothers. The main effect of this variable seems to be due to mother to child transmission. This can be verified if the variable is included whether the male partner is HIV infected, instead of the status of the mother. If the HIV status of a male household member has a significant impact on child mortality, this would suggest that the socio-economic consequences of HIV is also captured and would play also an important role for the mortality risk.[41]

[40] On possible explanation of this questionable result is the problem of underreporting. Especially the very poor and bad educated population sub group is very likely to conceal the death of a child, which then might lead distorted estimation results.

[41] In addition, interesting to note is that if the variable whether the child was breast fed immediately after birth is excluded from the model, the negative effect of the HIV status increases, which reflects the higher risk of mother to child transmission due to breastfeeding.

As shown in Table 6, the HIV status of a male household member (where the mother is not infected) has no significant effect on child mortality in all countries. This result seems to indicate that the main effect of HIV is through mother to child transmission rather due to the socio-economic impact of HIV. In other words, if a child lives in a HIV affected household, and if the infected person is not the mother, it seems that this does not automatically increase the mortality risk of the child.[42] However, the effect of the HIV status of the mother could also include the effect of less care capacity and not only the effect of mother to child transmission, even if the HIV status of the male partner shows no significant result. In general, the mother is the mein care giver of the children compared to the father. Therefore, if a HIV infected mother suffers from the epidemic, resulting in less care for the children, this is expected to have a much higher impact on the survival probability than less care capacities of an HIV infected male household member.

In addition, being HIV positive is clearly not the same as the situation where the household member has already started to suffer from AIDS, which is expected to have a more clear and significant negative impact on the household and on the welfare of the children. One possible way to separate HIV infected mothers among all infected mothers who also suffer already from AIDS is to compare them by their nutritional status. However, if, instead of HIV positive mothers, only those mothers were included who also have a BMI less then 18.5 did not change the results significantly. In addition, it is most likely that the effect of HIV on child mortality is underestimated. As the information on the child mortality rates are based on retrospective data collected from mothers that were alive at the time of the survey, the analysis misses the mortality among children whose mother had already died

[42]The effect of the HIV status of the partner might be mitigated by the asset index because HIV worsens the material well-being as a consequence of less ability to work and, therefore, decrease the care capacity and might increase the child mortality risk. Indeed, if the asset index is excluded from the regression, the coefficient becomes also positive in Burkina Faso and Kenya, but still remains insignificant.

from AIDS. The higher risk of dying for children whose mother died from AIDS is not evaluated resulting in an underestimation of the impact on HIV on child mortality.[43]

[insert Table 6 here]

An additional regression is implemented based on a combined data set of all children in the four countries. The results of this global regression is shown in Table A2, and confirm the results from Table 4 and Table 5. Also here, the HIV status of the mother has a strong impact on the mortality risk of the child, whereas if a positive test result of a male household member has no significant effect.

Table 7 shows the regression results for stunting. The coefficients of the stunting z-score follow the usual pattern across the four countries. For example, living in urban areas has a significant positive effect on the nutritional status of the child. This result is also found for the asset index and in Ghana, if the mother has received prenatal care. In contrast to the impact on child mortality, the educational level of the mother has a significant positive impact on on the nutritional status in Cameroon. Quite surprisingly, only for Ghana a significant positive effect of breastfeeding is found. Furthermore, and in contrast to other studies (see, e.g. Harttgen and Misselhorn, 2006), the nutritional status of the mother, measured in a low BMI, plays only a minor role for the nutritional status of the child. Looking at the impact of HIV on undernutrition, no significant impact is found in all four countries. If the mother is HIV positive seems to be of low importance for the nutritional status of the child, when controlling for other socio-economic characteristics.[44]

[43]However, this problem may be weakened by the fact that fertility rates are much lower among HIV-infected women (see, e.g. Gray et al, 1998 and United Nations, 2005a).

[44]Also if the nutritional status of the mother is excluded, which might capture the effect of HIV on the the mother, the HIV status has no significant impact on the nutritional status of the child. Also here, excluding the asset index from the regression does not change the results.

This results seems to indicate as well that being HIV positive does not automatically decrease the nutritional status of the child. However, again an underestimation of the impact of HIV is also very likely.

[insert Table 7 here]

Table 8 shows the results for school enrollment. Again, the coefficients show the expected directions. For example, the percentage of enrolled children in a household increases with the material welfare and the educational level of the parents. Table 8 also shows that the effect of gender on enrollment. In Burkina Faso, Ghana and Kenya girls are more likely to be enrolled than boys, whereas the opposite is found four Cameroon. In addition, more children are enrolled in school if the household head is female. Turning to the effect of HIV on the school enrollment, two different results are found. For Ghana and Kenya, no significant effect of HIV on school enrollment is found, which tends to confirm the previous results. However, for Burkina Faso and Cameroon, a significant negative impact of HIV on school enrollment is found. Regarding the question of the impact of HIV on the welfare of children this is a very interesting result. Whereas no impact of HIV was identified on undernutrition and the impact on mortality identified as mostly due to mother to child transmission, this result seems to indicate that already being HIV infected, without any information whether the individual already suffers from AIDS, has also a negative impact on the outcome of the children's welfare.

[insert Table 8 here]

6 Conclusion

This paper analyzed the effects of HIV-infected household members on child mortality, undernutrition and educational attainment for Burkina Faso, Cameroon, Ghana and Kenya. All four Sub-Saharan African countries are strongly affected by the HIV/AIDS epidemic and suffer from high rates of child mortality and undernutrition and from an overall low rate of school enrollment. The aim of the paper was to shed more light on the effects of the HIV/AIDS epidemic on the welfare of children's that are caused both by direct vertical transmission and by worsening socio-economic conditions as a result of the epidemic.

The results show strong evidence for a direct severe negative impact of HIV on child mortality through mother to child transmission, which increases the risk of child mortality in all four countries. When controlling for other individual and household characteristics, no indirect negative socio-economic effect of HIV was found for child mortality and undernutrition. One possible explanation for the limited socio-economic effects of HIV remains in a possible underestimation, because the analysis captures only those household member that were alive at the time of the survey and therefore the analysis miss the effects among children whose mother or other infected household member had already died from AIDS. However, a negative relationship between HIV and school enrollment was found in Burkina Faso and Cameroon. This last result seems to confirm that there are also exist negative socio-economic impacts of HIV on the welfare of children that go beyond the direct transmission of the epidemic.

One should be very careful, when drawing any policy implications from the result of an overall low indirect impact of HIV on children's welfare outcomes. The results cannot show who already suffers from AIDS, which then clearly lead to less care capacities and, therefore, to indirect negative effects on children. However, the negative impact of HIV on child mortality and education, which was also recently found by Graff Zivin et al (2006), strongly argues for better treatment opportunities for HIV infected persons. The future of the HIV/AIDS epidemic and its influences depends heavily on a better education of people about the infection risks to reduce further spreading. And the socio economic impact depends heavily on appropriate policy instrument that compensate the lower care capacities of households affected by the epidemic. Therefore, future research on the impact of HIV on household and children should further focus on the indirect impacts of the epidemic, but will depend heavily on data availability.

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Tables and Figures

Table 1
HIV infection rates
(percentage)

HIV infection*	Burkina Faso 2003	Cameroon 2004	Ghana 2003	Kenya 2003
Household (adults)				
Total	1.88	5.50	2.71	6.84
Agegroup 15-24	1.34	3.38	1.18	4.13
Agegroup 25-59	2.26	7.05	3.65	8.64
Urban	4.01	6.66	2.90	5.82
Rural	1.22	3.40	2.59	7.42
Mother				
Total	1.50	5.78	2.21	8.88
Agegroup 15-24	1.16	4.88	1.82	8.88
Agegroup 25-59	1.63	6.25	2.31	8.92
Urban	4.46	8.03	1.85	13.39
Rural	1.04	4.04	2.38	7.85

Source: Demographic and Health Surveys (DHS); own calculations.
Note: *Positive tested for HIV type-1 or HIV type-2.

Table 2
HIV infection by asset index
(percentage)

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Ratio 1/5
HIV infection						
Burkina Faso 2003	0.87	1.33	3.90	2.27	8.99	0.10
Cameroon 2004	5.66	8.05	17.69	18.48	20.73	0.27
Ghana 2003	1.91	2.53	4.10	4.15	2.90	0.66
Kenya 2003	12.21	9.60	7.13	7.56	10.51	1.16

Source: Demographic and Health Surveys (DHS); own calculations.
Notes: The asset index is calculated based on a factor analysis. As variables to calculate the asset index, dummies are included whether the following assets exist or not: radio, TV, refrigerator, bike, motorized transport, low floor material, toilet, drinking water. Quintile one corresponds to the poorest and quintile five to the richest population subgroup.

Table 3
Child mortality, undernutrition and education
by asset index quintiles
(percentage)

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total	Ratio 1/5
Child mortality							
Burkina Faso 2003	17.03	19.06	18.08	15.60	10.62	16.47	1.60
Cameroon 2004	15.64	14.63	13.22	15.93	8.90	14.31	1.76
Ghana 2003	10.74	10.40	10.82	10.92	7.52	10.68	1.43
Kenya 2003	11.94	14.13	8.83	10.42	8.42	11.36	1.42
Stunting							
Burkina Faso 2003	0.52	0.47	0.47	0.38	0.29	0.44	1.80
Cameroon 2004	0.44	0.42	0.41	0.27	0.17	0.36	2.59
Ghana 2003	0.47	0.37	0.36	0.27	0.19	0.36	2.47
Kenya 2003	0.45	0.37	0.37	0.24	0.19	0.35	2.37
School enrollment							
Burkina Faso 2003	21.09	31.67	35.60	50.15	63.08	37.63	0.33
Cameroon 2004	61.61	63.55	70.91	70.36	79.15	67.66	0.78
Ghana 2003	43.70	53.78	55.53	53.16	54.01	51.54	0.81
Kenya 2003	64.71	72.60	66.89	55.97	57.40	64.31	1.13

Source: Demographic and Health Surveys (DHS); own calculations.
Notes: Child mortality rate shows the percentage of children under five years of age who died within the last 12 months compared to all children under five years of age living in the respective quintile. The stunting rate shows the percentage of stunted children in the respective quintile compared to all children under five years of age. A child is considered as stunted if the height over age z-score is below -2 standard deviations from the reference category. School enrollment refer to children between five and fifteen and show the percentage of enrolled children living in households in the respective quintiles. The asset index is calculated based on a factor analysis. As variables to calculate the asset index, dummies are included whether the following assets exist or not: radio, TV, refrigerator, bike, motorized transport, low floor material, toilet, drinking water. Quintile one corresponds to the poorest and quintile five to the richest population subgroup.

Table 5
Household demographic and socio-economic characteristics,
sexual behavior and HIV/AIDS knowledge

	Burkina Faso 2003	Cameroon 2004	Ghana 2003	Kenya 2003
Urban	17.31	40.98	30.12	24.69
Female headed household	6.77	20.74	25.07	26.88
Household size	8.05	6.98	5.76	5.65
Age of head	44.06	41.65	41.57	38.26
Head has primary education	8.71	48.09	38.72	30.93
Head has secondary education	1.67	5.89	8.62	23.07
Mother's BMI<18.5	17.56	5.48	8.52	12.06
Age of first birth	18.87	18.42	19.95	19.16
Age of first marriage	17.30	17.36	18.64	18.86
Married	86.08	69.23	82.10	75.94
Number of children	4.14	3.74	3.69	3.65
Sex of child is female	49.82	49.67	49.65	49.89
Breastfeeding	41.78	35.40	53.54	55.39
Breastfeeding (HIV-positive)	40.00	34.85	45.45	53.50
Complete vaccination	0.58	0.644	0.75	0.70
Prenatal care	58.28	61.57	74.74	68.00
Child received vitamin A	23.92	31.14	48.42	14.92
Child had recently fever	85.44	48.90	32.59	69.43
Piped water	3.54	7.43	8.19	13.92
AIDS knowledge and sexual behavior				
Ever heard from AIDS	96.74	97.99	97.30	97.81
Knows someone with AIDS	47.45	45.43	37.72	71.98
Spoke with spouse about AIDS	35.84	60.29	56.13	61.17
Knowing about MTCT*	64.46	70.37	75.72	95.65
Knowing risk factors**	9.09	24.10	35.47	12.47

Source: Demographic and Health Surveys (DHS); own calculations.
Note: *Dummy whether knowing about mother to child transmission of HIV/AIDS. **Dummy whether knowing at least about one of the following risk factors: Prostitution, partner with many partners, sex with intravenous drug users, sharing razor blades with aids patients.

Table 5
Regression results of child mortality
(cox proportional hazard model)

	Burkina Faso 2003	Cameroon 2004	Ghana 2003	Kenya 2003
Age (mother)	-0.150**	-0.139**	-0.093	-0.135
	(0.060)	(0.062)	(0.074)	(0.090)
$Age^2/100$ (mother)	0.233**	0.216**	0.146	2.317*
	(0.091)	(0.100)	(0.110)	(1.409)
Sex is female	0.056	-0.089	-0.100	-0.303*
	(0.099)	(0.101)	(0.121)	(0.147)
Urban	0.291	0.070	-0.073	-0.114
	(0.209)	(0.147)	(0.183)	(0.246)
Asset index	0.008	-0.137	0.227	0.299*
	(0.111)	(0.103)	(0.127)	(0.169)
Household size (adults) (IV)	0.009	0.014	-0.012	0.104
	(0.023)	(0.030)	(0.055)	(0.075)
First born	0.049	-0.155	0.007	-0.354
	(0.164)	(0.154)	(0.189)	(0.237)
Female headed household	-0.512*	-0.228	0.281*	0.048
	(0.286)	(0.151)	(0.153)	(0.185)
Prenatal care	-0.543**	-0.635**	-0.733**	-0.625**
	(0.119)	(0.117)	(0.128)	(0.161)
Immediate breastfeeding	-0.045	-0.348**	-0.757**	-0.785**
	(0.106)	(0.120)	(0.134)	(0.160)
Mother has primary education	-0.425	-0.068	-0.277	0.051
	(0.473)	(0.145)	(0.161)	(0.227)
Complete vaccination	-0.917**	-0.998**	-0.602**	-0.751**
	(0.117)	(0.115)	(0.129)	(0.160)
Vitamin A	0.174*	0.027	-0.175	-0.041
	(0.091)	(0.108)	(0.125)	(0.220)
Recently had fever (% in cluster)	0.322	0.363	0.898*	-0.194
	(0.269)	(0.320)	(0.388)	(0.363)
Piped drinking water (% in cluster)	-0.699	-0.405	-0.542	-0.597
	(0.624)	(0.411)	(0.436)	(0.454)
HIV positive (mother)	0.863**	0.820**	1.031**	0.647**
	(0.304)	(0.177)	(0.275)	(0.227)
Obs.	3359	3731	3501	2323

Source: Demographic and Health Surveys (DHS); own calculations.
Notes: *P-value<0.1. **P-value<0.01. The household size enters via an instrumental regression into the model. As instrument the mean household size per cluster is used.

Table 6
Regression results of child mortality
(cox proportional hazard model)

	Burkina Faso 2003	Cameroon 2004	Ghana 2003	Kenya 2003
Age (mother)	-0.145**	-0.121*	-0.070	-0.135
	(0.060)	(0.062)	(0.073)	(0.090)
$Age^2/100$ (mother)	0.225**	0.189*	0.115	2.287
	(0.091)	(0.100)	(0.109)	(1.404)
Sex is female	0.058	-0.099	-0.089	-0.276
	(0.099)	(0.101)	(0.120)	(0.146)
Urban	0.308	0.071	-0.093	-0.074
	(0.209)	(0.147)	(0.181)	(0.245)
Asset index	0.006	-0.120	0.202	0.304*
	(0.111)	(0.104)	(0.119)	(0.168)
Household size (adults) (IV)	0.009	0.009	-0.013	0.105
	(0.023)	(0.029)	(0.050)	(0.075)
First born	0.049	-0.139	0.054	-0.363
	(0.164)	(0.155)	(0.188)	(0.235)
Female headed household	-0.464	-0.140	0.308	0.087*
	(0.286)	(0.148)	(0.151)	(0.184)
Prenatal care	-0.528**	-0.610**	-0.719	-0.604**
	(0.118)	(0.116)	(0.128)	(0.161)
Immediate breastfeeding	-0.044	-0.368	-0.795	-0.799
	(0.107)	(0.120)	(0.129)	(0.160)
Mother has primary education	-0.416	-0.030	-0.283	0.056*
	(0.473)	(0.145)	(0.157)	(0.228)
Complete vaccination	-0.925**	-1.041**	-0.596	-0.770
	(0.117)	(0.115)	(0.128)	(0.160)
Vitamin A	0.165	0.033	-0.161	-0.031
	(0.092)	(0.108)	(0.122)	(0.219)
Recently had fever (% in cluster)	0.327	0.382	0.831	-0.166*
	(0.271)	(0.325)	(0.367)	(0.363)
Piped drinking water (% in cluster)	-0.690	-0.398	-0.481	-0.564
	(0.626)	(0.416)	(0.436)	(0.458)
HIV positive (partner)	0.120	0.216	-0.119	0.288
	(0.518)	(0.268)	(0.712)	(0.439)
Obs.	3359	3731	3501	2329

Source: Demographic and Health Surveys (DHS); own calculations.
Notes: *P-value<0.1. **P-value<0.01. The household size enters via an instrumental regression into the model. As instrument the mean household size per cluster is used.

Table 7
Regression results of stunting
(OLS regression)

	Burkina Faso 2003	Cameroon 2004	Ghana 2003	Kenya 2003
Age	-0.131**	-0.094**	-0.101**	-0.095**
	(0.007)	(0.007)	(0.006)	(0.008)
$Age^2/100$	0.175**	0.132**	0.141**	0.137**
	(0.012)	(0.011)	(0.010)	(0.013)
Sex is female	0.148**	0.018	0.208**	0.241**
	(0.062)	(0.056)	(0.049)	(0.066)
Urban	0.330**	0.118*	0.128*	0.147
	(0.116)	(0.070)	(0.069)	(0.095)
Asset index	0.227**	0.359**	0.335**	0.309**
	(0.055)	(0.042)	(0.040)	(0.055)
Household size (adults)(IV)	-0.002	-0.016*	-0.003	0.013
	(0.007)	(0.008)	(0.011)	(0.016)
First born	-0.164*	-0.004	0.048	0.021
	(0.083)	(0.070)	(0.062)	(0.079)
Female headed household	0.265*	0.127*	-0.096	0.094
	(0.137)	(0.075)	(0.061)	(0.078)
Prenatal care	0.063	0.004	0.211**	-0.097
	(0.074)	(0.065)	(0.061)	(0.079)
Immediate breastfeeding	0.049	0.062	0.087*	-0.019
	(0.064)	(0.059)	(0.050)	(0.066)
Mother has primary education	0.150	0.199**	0.015	0.099
	(0.192)	(0.069)	(0.058)	(0.091)
BMI of mother < 18.5	-0.003	-0.055	-0.028	-0.190*
	(0.082)	(0.119)	(0.087)	(0.097)
Age of first birth	0.011	0.007	-0.009	0.024*
	(0.011)	(0.009)	(0.007)	(0.011)
Vaccination	0.080	0.034	0.095	0.019
	(0.069)	(0.066)	(0.061)	(0.079)
Vitamin A	0.072	0.030	0.008	0.045
	(0.059)	(0.051)	(0.045)	(0.095)
HIV positive (mother)	-0.063	-0.025	0.004	-0.016
	(0.280)	(0.131)	(0.182)	(0.126)
Constant	-0.125	-0.200	-0.074	-0.549*
	(0.245)	(0.202)	(0.187)	(0.265)
R^2	0.194	0.142	0.184	0.136
Obs.	2545	2869	2876	1895

Source: Demographic and Health Surveys (DHS); own calculations.
Notes: *P-value<0.1. **P-value<0.01. The household size enters via an instrumental regression into the model. As instrument the mean household size per cluster is used.

Table 8
Regression results of school enrollment
(OLS regression)

	Burkina Faso 2003	Cameroon 2004	Ghana 2003	Kenya 2003
Age	0.002	0.003	-0.001	-0.001
	(0.002)	(0.006)	(0.002)	(0.002)
$Age^2/100$	-0.004	-0.002	0.002	-0.002
	(0.003)	(0.011)	(0.003)	(0.004)
Age (mother)	0.000	-0.007*	0.002*	0.003
	(0.001)	(0.002)	(0.001)	(0.001)
Urban	0.169**	0.053	-0.018	-0.147**
	(0.032)	(0.071)	(0.025)	(0.033)
Household size (adults) (IV)	0.058**	0.477**	0.096**	0.148**
	(0.004)	(0.016)	(0.010)	(0.014)
Female children in household (%)	0.115**	-0.800**	0.184**	0.169**
	(0.034)	(0.103)	(0.030)	(0.041)
Asset index	0.132**	0.041	0.073**	0.074**
	(0.016)	(0.047)	(0.015)	(0.020)
Head has no education	0.054	-0.498**	-0.018	-0.095**
	(0.082)	(0.152)	(0.040)	(0.036)
Head has primary education	0.191*	-0.111	0.062	-0.044
	(0.084)	(0.144)	(0.037)	(0.036)
Mother has primary education	0.128**	0.383**	0.033	0.148**
	(0.030)	(0.058)	(0.022)	(0.025)
Complete vaccination	0.085**	0.108**	0.034	0.020
	(0.018)	(0.062)	(0.021)	(0.027)
Female headed household	0.066*	0.622**	0.135**	0.197**
	(0.039)	(0.077)	(0.024)	(0.028)
Mother works for cash	-0.030	0.111*	-0.096*	-0.003
	(0.032)	(0.064)	(0.028)	(0.024)
HIV positive (mother)	-0.155*	-0.161*	0.045	0.023
	(0.071)	(0.091)	(0.063)	(0.044)
Constant	-0.263*	-0.532*	-0.126*	-0.246**
	(0.093)	(0.191)	(0.057)	(0.063)
R^2	0.259	0.328	0.110	0.199
Obs.	3323	3575	3421	2261

Source: Demographic and Health Surveys (DHS); own calculations.
Notes: *P-value<0.1. **P-value<0.01. The household size enters via an instrumental regression into the model. As instrument the mean household size per cluster is used.

Figure 1
Number of reported AIDS cases by year

Source: WHO (2006a).

Appendix

Table A1
Sample Comparison
(probability of being in the full sample)
(logit regression)

	Burkina Faso 2003	Cameroon 2004	Ghana 2003	Kenya 2003
Age (child)	0.000	0.002	0.004	-0.003
	(0.001)	(0.005)	(0.004)	(0.002)
Age (mother)	-0.003	-0.006	-0.007	0.002
	(0.002)	(0.009)	(0.006)	(0.003)
Urban	0.187*	1.337*	0.517*	0.269*
	(0.067)	(0.217)	(0.173)	(0.066)
Household size	0.008	-0.075*	0.063*	0.027
	(0.004)	(0.031)	(0.027)	(0.013)
Female headed household	-0.310	-0.118	0.003	0.126
	(0.101)	(0.249)	(0.192)	(0.067)
Head has primary education	-0.041	0.402	-0.475*	0.155
	(0.085)	(0.224)	(0.175)	(0.064)
Head has secondary education	0.244	0.850*	-0.369	0.079
	(0.194)	(0.320)	(0.303)	(0.077)
Mother's BMI<18.5	0.012	-0.682	-0.832	-0.262*
	(0.054)	(0.598)	(0.368)	(0.083)
Mother works for cash	10.109	-0.258	0.103	-0.020
	(0.079)	(0.186)	(0.235)	(0.056)
Married	-0.142	0.039	0.033	0.073
	(0.086)	(0.216)	(0.218)	(0.071)
Sex of child is female	-0.045	-0.057	0.004	-0.019
	(0.042)	(0.177)	(0.144)	(0.053)
First born	-0.047	0.208	0.064	0.038
	(0.055)	(0.200)	(0.184)	(0.065)
Breastfeeding	-0.030	0.286	-0.131	0.077
	(0.043)	(0.181)	(0.145)	(0.054)
Complete vaccination	0.030	-0.304	-0.604*	-0.064
	(0.045)	(0.201)	(0.155)	(0.061)
Prenatal care	0.080	0.296	0.118	-0.109
	(0.046)	(0.208)	(0.166)	(0.061)
Constant	0.717**	-3.621**	-2.699**	0.073**
	(0.135)	(0.526)	(0.463)	(0.158)
R^2	0.001	0.000	0.000	0.000
Obs. (full sample)	10645	8125	3844	5949
Obs. (HIV sub-sample)	3578	4082	3627	2447

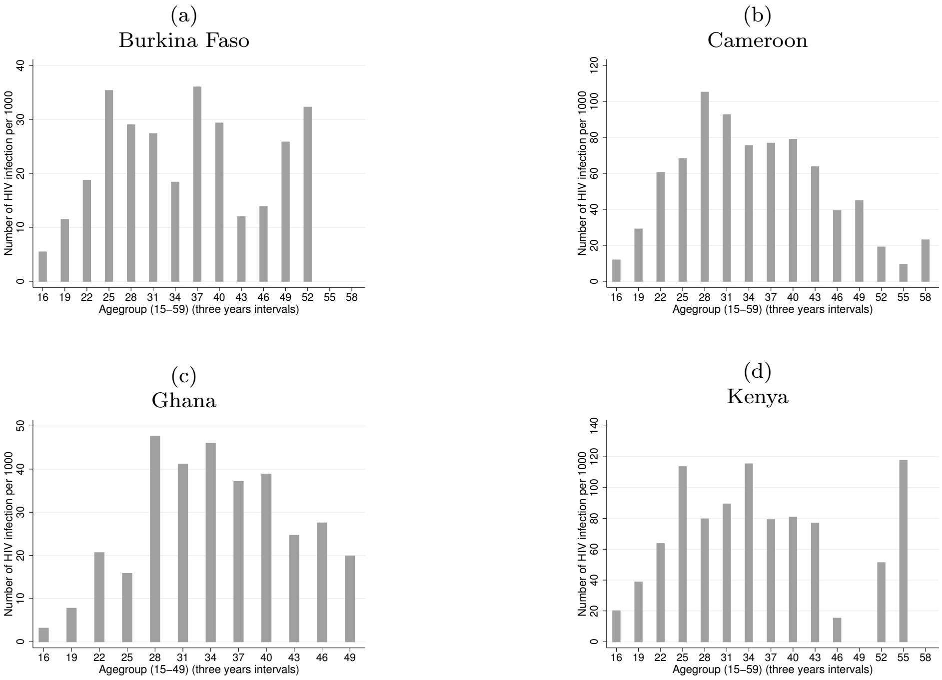
Source: Demographic and Health Surveys (DHS); own calculations.
Notes: *P-value<0.1. **P-value<0.01.

Table A2
Regression results of child mortality
(global data set)
(proportional hazard model)

	(1)		(2)	
	Coefficient	Std. error	Coefficient	Std. error
Age (mother)	0.019*	(0.011)	0.020*	(0.011)
$Age^2/100$ (mother)	-0.024	(0.019)	-0.026	(0.019)
Sex is female	-0.090*	(0.055)	-0.086	(0.055)
Urban	0.032	(0.082)	0.036	(0.082)
Asset index	0.012	(0.048)	0.026	(0.048)
Household size (adults) (IV)	-0.005	(0.008)	-0.006	(0.008)
First born	0.076	(0.081)	0.077	(0.081)
Female headed household	-0.025	(0.081)	0.022	(0.080)
Prenatal care	-0.562**	(0.062)	-0.548*	(0.062)
Immediate breastfeeding	-0.445**	(0.060)	-0.449*	(0.060)
Mother has primary education	-0.109	(0.089)	0.094	(0.089)
Complete vaccination	-0.835**	(0.060)	-0.848**	(0.061)
Vitamin A	0.059	(0.056)	0.057	(0.056)
Percent recently had fever	-0.085	(0.307)	0.050	(0.306)
Percent secondary schooling (head)	-0.001	(0.380)	0.189	(0.379)
Percent piped water	-3.893*	(2.060)	-3.703*	(0.066)
HIV positive (mother)	0.751**	(0.108)		
HIV positive (partner)			0.086	(0.186)
Obs.	12928		12928	

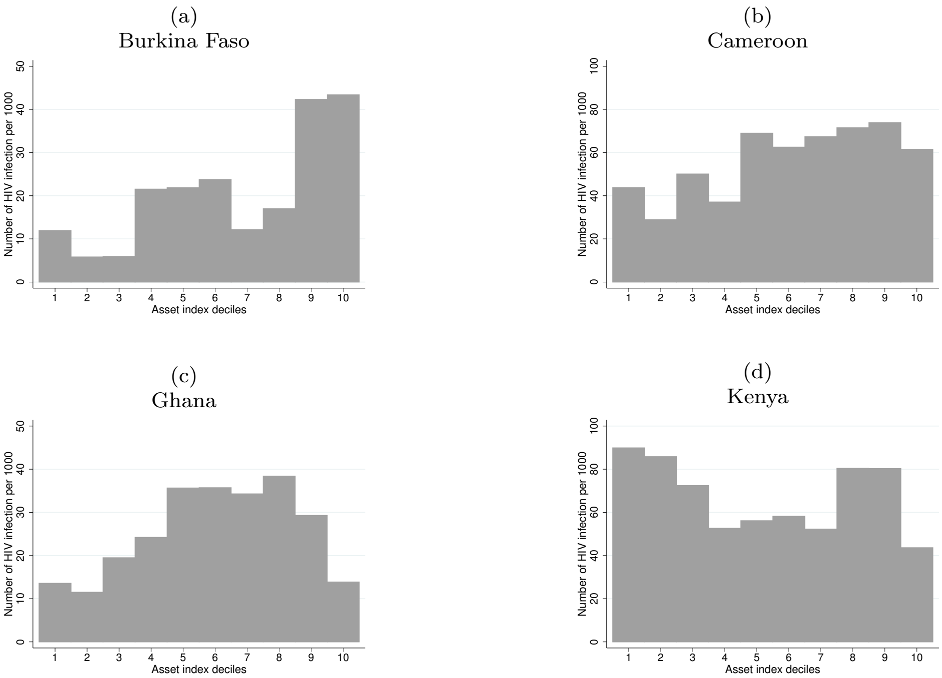
Source: Demographic and Health Surveys (DHS); own calculations.
Notes: *P-value<0.1. **P-value<0.01. The household size enters via an instrumental regression into the model. As instrument the mean household size per cluster is used.

Figure A1
HIV infection by Age



Source: Demographic and Health Surveys (DHS); own calculations.

Figure A2
HIV infection by asset index



Source: Demographic and Health Surveys (DHS); own calculations.